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# GRADUATE SCHOOL

OF THE

# UNIVERSITY OF ILLINOIS

1898-99

# GRADUATE SCHOOL

OF THE

# UNVERSITY OF ILLINOIS

1898-99

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# CALENDAR

## 1898–99

### FALL TERM, 1898

| | |
|---|---|
| Sept. 12, 13, Monday and Tuesday. | Registration Days. |
| Nov. 7, Monday. | Latest date for announcing Subjects of Theses |
| Dec. 14, Wednesday. | Term Examinations begin. |
| Dec. 16, Friday. | Term ends. |

### WINTER TERM, 1899.

| | |
|---|---|
| Jan. 3, Tuesday. | Registration Day. |
| March 15, Wednesday. | Term Examinations begin. |
| March 17, Friday. | Term ends. |

### SPRING TERM, 1899.

| | |
|---|---|
| March 28, Tuesday. | Registration Day. |
| June 1, Thursday. | Latest Day for Acceptance of Theses. |
| June 7, Wednesday. | Term Examinations begin. |
| June 11, Sunday, | Baccalaureate Address. |
| June 12, Monday. | Class Day. |
| June 13, Tuesday. | Alumni Day and Oratorical Contest. |
| June 14, Wednesday. | Twenty-eighth Annual Commencement. |

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1899/99

# GRADUATE SCHOOL

## Organization

The graduate school is in charge of the Council of Administration of the University. The dean of the general faculty is the executive officer of the school, and he should be consulted on all matters pertaining thereto.

## Admission and Registration

Graduates of the University of Illinois, and of other colleges and universities of approved standing, may apply for membership in the graduate school upon a blank furnished for the purpose. The acceptance of their credentials entitles them to enrollment. Other persons, suitably qualified, may gain admission by special vote of the Council of Administration upon such conditions as may be imposed in each case.

Registration may be accepted at any time, other than the regular registration days in September, January and March, but the time-limit required for degrees counts from the date of registration.

With the exceptions named below, all members of the graduate school are required to be in regular attendance at the University, and to do all the work for which they are registered in the departments to which such work belongs. Graduates from baccalaureate courses of the University of Illinois may register as non-resident members of the graduate school; and all members of the school who have completed the residence period required for advanced degrees may register as non-residents while completing the work required for such degrees.

## Studies and Examinations

Each student must select one principal line of study, called his major subject, and upon this major subject at least one-half of his work must be done; and any greater proportion of his time, up to the whole of it, may be thus devoted if proper approval is had. When work upon the selected major subject is not arranged to require all of the student's attention, he must choose one or two minor subjects, as may be necessary to complete a full course of study.

The major study must be approved as graduate work for this University. The courses of instruction hereinafter described [p. 9] are suggested offerings. By arrangement with heads of departments other subjects may often be chosen. The minor subjects may, upon approval, be chosen from the offerings to graduates, or, except in engineering, from undergraduate courses, exclusive of those usually open to freshmen. For courses in law, a minor subject may be chosen from the Department of Public Law and Administration [p. 12].

In architectural and engineering subjects, at least the major line of study, and not less than two-thirds of the entire work, must be taken from lists marked "primary," and any remaining amount to complete a full course may be taken from those designated "secondary," under the same head with the primary list.

The head of each department in which a student does his major work is charged with the direction and supervision of such major work, and, in a general way, with the supervision of the student's entire course of study.

## Instruction

In general, the instruction in courses open only to graduates consists in suggesting and directing courses of reading, in supervising investigations, and in conducting oral and written discussions. Members of the graduate school taking class work with undergraduates may be assigned extra reading or laboratory investigation. In all cases heads of departments exercise great freedom in adapting courses and methods of instruction to individual needs.

## Degrees

SECOND DEGREES.—The *second* degrees conferred by the University in the Graduate School are as follows:

*Master of Arts*, after Bachelor of Arts.

*Master of Law*, after Bachelor of Law.

*Master of Science*, after Bachelor of Science in Agriculture and Science.

*Master of Architecture*, after Bachelor of Science in courses in Architecture and Architectural Engineering.

*Civil Engineer*, after Bachelor of Science in the course in Civil Engineering.

*Electrical Engineer*, after Bachelor of Science in the course in Electrical Engineering.

*Mechanical Engineer*, after Bachelor of Science in the course in Mechanical Engineering.

Each candidate for a second degree is required to register in the graduate school; to conform to the rules regarding registration, etc.; to pursue an approved course of study for at least one academic year in residence, or in the case of graduates of the University of Illinois for three years *in absentia;* to pass satisfactory examinations upon all the studies of the approved

course, and to present an acceptable thesis in the line of his major subject of study.

Doctor's Degree.—The degree of *Doctor of Philosophy* may be conferred upon any member of the graduate school of not less than three years' standing who shall have made high attainments in scholarship, including a sufficient knowledge of the Latin, French, and German languages to serve the purposes of research in his principal specialty; who shall have shown marked ability in some line of literary or scientific investigation; and shall have presented a thesis giving clear indications of such scholarship and of such power of research. At least the first two, or the last one, of the three years of study must be in residence at the University of Illinois, and the entire course of study must be in accordance with the regulations of the graduate school.

## Fellowships

The Trustees of the University have established eight fellowships, each with a stipend of three hundred dollars, payable in ten monthly instalments.

Nominations to fellowships, accompanied by assignments to special departments of the University for instructional work, are made by the Council of Administration to the Trustees of the University, upon applications received by the President of the University each year, not later than the twenty-fifth day of April.

Nominations to fellowships are made upon the grounds of worthiness of character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Consideration is also given to the probable value or usefulness of the services of the

candidate as an assistant in instruction. Other things being equal, preference is given to those who have pursued a course of undergraduate work in which a major subject has been made a leading feature through two or more years.

Candidates must present, with their applications, full information concerning themselves and their qualifications for advanced study and research work, including any written or printed essays or results of investigation, and must name the subject in which they wish to do their major work.

Fellowships are good for one year. Appointments may not usually be renewed to the same persons, and in no case for more than one additional year; but an appointment as *honorary fellow*, without stipend, may be made as specified for paid fellowships in the case of any one who has held a regular fellowship and has shown distinguished merit in his work.

## Libraries and Laboratories

The new library building, one of the best in the country, offers excellent facilities for the work therein conducted, and liberal appropriations of money make it possible in most cases to provide the necessary literature in special lines of research. There are now available to students 40,000 bound volumes and 21,000 pamphlets.

The chemical, physical, biological, geological and engineering laboratories afford abundant opportunities for research work. The agricultural experiment station and the biological station on the Illinois river, each offers special advantages for investigation. The astronomical observatory is well fitted for certain courses of practical study and research. All things

considered, the various laboratory equipments are equaled in only a few institutions in the country.

## Expenses

The only fees in the graduate school are ten dollars for matriculation, from those not already matriculates of the University, and five dollars for diploma. Actual laboratory and similar expenses must be paid; otherwise there are no charges of any kind.

Board can be had in clubs and in private families at from three and a half to six dollars a week. The average price is from four to four and a half dollars.

## Resident Graduates

Individuals holding bachelor degrees not desiring to enter, or not eligible for membership in, the Graduate School, may gain admission to the University as "resident graduates," and may elect such undergraduate courses as their previous training justifies. Such students may enter for a second bachelor's degree from the University.

# COURSES OF INSTRUCTION.

An asterisk (*) indicates that the course it precedes is primarily for undergraduates, but is open to graduates as major work, subject to conditions prescribed by the head of the department. Courses without an asterisk are offered only to graduates.

Unless otherwise stated the work continues through the year. Information concerning the number of hours a week must be obtained by inquiry.

Indications are given under the group headings of the amount of preparatory study required for admission to the courses, expressed in years of undergraduate instruction as given in the University of Illinois, or an accepted equivalent. Of course this is exclusive of the requirements for admission to undergraduate work. In all cases admission is conditioned on the approval of the heads of the departments concerned.

## LANGUAGE AND LITERATURE

Admission requirements: In Greek, Latin, French, and German, three years; in English, two years.

### GREEK—PROFESSOR MOSS

*Herodotus.*—Selected portions for reading. Attention will be directed during the first half of the year to the text; during the second half to literary and historical criticism.

*Plato.*—Translation of selected dialogues, with critical study of a restricted group.

### LATIN—PROFESSOR BARTON

*Catullus.*—Selected readings. The position of Catullus and Horace in lyric poetry; the indebtedness of Horace, Vergil and the elegiac poets to Catullus.

*The Elegiac Poets.*—Selections from Ovid, Propertius, and Tibullus.

*Roman Literary Prose Style.*—Selected readings to trace in a connected manner the characteristics of prose style under the Republic, during the time of Augustus, and under the early Empire.

ENGLISH—PROFESSOR DODGE AND ASSISTANT PROFESSOR JAYNE.

The courses in literature are:—
**Old English Poetry.*
**Fourteenth and Fifteenth Century Literature.*
**Seminary in Comparative Modern Fiction.*
**Shakespere and the History of the Drama.*
**History of English Criticism.*
**Old English (Anglo-Saxon) Grammar and Prose.*

*The linguistic courses are:—
**Early English.*
**History of the English Language.*
*Icelandic.*—Grammar and reading of prose.
*Danish.*—Grammar and reading of prose and poetry.

GERMAN—ASSOCIATE PROFESSOR RHOADES AND MR. MEYER

**Study of Goethe.*—Goethe's Life and Works, with translation and collateral reading.

**History of German Literature.*—Lectures and assigned collateral reading of English books bearing on the subject.

FRENCH—ASSISTANT PROFESSORS PIATT AND FAIRFIELD

**Eighteenth Century.*—The course will consist of: (1) Lectures in French, themes and collateral reading; reading of selected works of Voltaire, Montesquieu, Rousseau, Chènier, and Beaumarchais. (2) Assigned Readings. (3) Themes in French upon subjects connected with the course.

**Old French Readings.*—(*a*) Clèdat, Les Auteurs Français du Moyen Age; Suchier, Aucassin et Nicolete; Gautier, La Chanson de Roland. Translation and comparison with the modern idiom. Study of the laws of phonetic changes. Lectures upon Old French philology. (*b*) A systematic study of special topics: French poets of the sixteenth century. Malherbe; his school and his influence. Sacred eloquence of the seventeenth century.

## PHILOSOPHY, PSYCHOLOGY AND PEDAGOGY

Admission requirements: One year.

PHILOSOPHY—ASSISTANT PROFESSOR DANIELS

**Advanced Philosophy.*—A critical study of Lotze's Microcosmus together with supplementary readings and discussions upon suggested topics.

**The Philosophy of Kant.*—A critical study of the Critique of Pure Reason and the Critique of Practical Reason.

**Esthetics.*—A brief history and a critical study of the various theories of the beautiful.

PSYCHOLOGY—DR. HYLAN

*Special Investigations.*—A research course consisting in the investigation of special problems.

PEDAGOGY—PROFESSOR TOMPKINS AND ASSISTANT PROFESSOR MCGILVREY

**The Psychological Factor in Educational Method.*—(a) Educational psychology. (b) The course of study. *Fall term.*

**Special Methods in Subjects*, as determined by the logic of the subject and by the learning mind. These exemplify in concrete operation all the foregoing laws. *Winter and spring terms.*

*The Nature and Purpose of Education* as revealed in the nature and purpose of human life, as interpreted in Literature and Philosophy.

*Universal Method in Education* as determined by the three organic phases of life—logical, ethical, esthetical.

*The Philosophy of Method* as illustrated in the teaching of various subjects.

*The Philosophy of School Organization*, Management, and Supervision as determined by the purpose and process of education.

*Educational Ideals and Methods.*—(a) Historical development; (b) present condition, problems and theories.

*School Systems*, past and present, as determined by their historical setting and by the educational theories of the times.

**POLITICAL SCIENCE: Economics, History, and Public Law and Administration.**

Admission requirements: One year.

ECONOMICS—PROFESSOR KINLEY AND DR. HAMMOND

**Money and Banking.—Winter and spring terms.*

**Public Finance.—Fall, winter and spring terms.*

**Financial History of the United States.*—The course begins with Hamilton's administration of the Treasury. *Fall and winter terms.*

**The Transportation Problem.—Spring term.*

**The Labor Problem.—Fall term.*

**The Monopoly Problem.—Winter term.*

**Theories of Production and Consumption.—Fall and winter terms.*

**Distribution of Wealth.*—This course deals rather with concrete problems of distribution than with pure theory. *Fall, winter and spring terms.*

*The Theory of Value.*—Special attention is paid to recent development. *Fall, winter and spring terms.*

*The Theory of Distribution.—Fall, winter and spring terms.*

HISTORY—ASSOCIATE PROFESSOR GREENE AND MR. ————

**American History.—Fall, winter and spring terms.*

**Mediæval History and Institutions.—Fall and winter terms.*

**The Period of the Renaissance.—Spring term.*

**English Constitutional and Legal History.—Fall, winter and spring terms.*

**The French Revolution and the Nineteenth Century.—Fall, winter and spring terms.*

**Europe from the Age of Louis XIV. to the Present Time.*

*Seminary in American History.*—Selected topics relating to the development of the West and its influence on national politics.

*Seminary in European History.*—Selected topics in the history of English institutions.

PUBLIC LAW AND ADMINISTRATION—ASSISTANT PROFESSOR TOOKE

**Comparative Constitutional Law.—Fall, winter, and spring terms.*

**Comparative Administrative Law.—Fall, winter, and spring terms.*

**International Law.—Winter and spring Terms.*

**Roman Law.—Winter and spring terms.*

**Seminary in Public Law.—Fall, winter, and spring terms.*

## LAW

Admission requirements: An undergraduate course in law.

| MAJOR SUBJECTS. | COLLATERAL MINOR SUBJECTS. |
|---|---|
| Law of Real Property. | Law of Personal Property. |
| Construction of Contracts. | Statutory Construction. |
| Wills and Administration. | Theory and Practice of Conveyancing. |
| Commercial Law. | Guaranty and Suretyship. |
| Law of Corporations, Private and Municipal. | Railroad or Insurance Law. |

## NATURAL and PHYSICAL SCIENCE and MATHEMATICS

Admission requirements: One year in Botany, Zoology, and Physics; two years in Chemistry and Mathematics; one term in Mineralogy, and two years in Geology, Physiology, and Astronomy.

BOTANY—PROFESSOR BURRILL

**Bacteriology.*—An introduction to existing knowledge upon the subject, and methods of experimentation and research.

**Systematic Botany.*—The morphology and affinities of selected groups of plants, together with studies upon life histories. *Fall and winter terms.*

**Reproduction and Development.*—Special experimental and research work in vegetable physiology and embryology. *Spring term.*

**Economic Botany.*—Useful and harmless plants, especially those affecting agricultural and horticultural interests and of prominence in the arts. *Winter term.*

*Biological Botany.*—Research work with living vegetation in the laboratory and field in working out special problems in the development, physiology, and pathology of plants.

*Systematic Botany.*—Critical and comparative studies of species included in chosen groups or from selected geographical areas.

*Advanced Bacteriology.*—Investigations upon morphologic and physiologic variation due to treatment; systematic studies upon the number, validity, and relationship of species; researches upon special saprophytic or parasitic kinds of bacteria and upon methods of favoring or combating their activities.

*Evolution of Plants.*—The influence of environment, effects of self and cross fertilization, tendencies of variation, philosophy of selection, nature and laws of heredity.

ZOÖLOGY—PROFESSOR FORBES AND DR. KOFOID

**Embryology.*—Germ cells, and the process of maturation, fertilization, cleavage, and gastrulation. The development of the chick with preparations of the amphibian embryo for comparison.

**Advanced Zoology.*—Three main lines of work are provided for: (*a*) Systematic reading of general zoology together with lectures on the morphology, physiology, and œcology of special groups. (*b*) Seminary work. (*c*) Zoölogical research work. This may be pursued at the University Biological Station on the Illinois River during the summer months.

**General Entomology.*—It is intended that the student shall come through this course competent to determine, to draw, and to describe species, and experienced in the various operations of field, laboratory, library, and economic entomology.

*Advanced Entomology.*—Special courses in either technical or practical entomology.

*Systematic and Faunistic Zoology.*—This course consists of studies of invertebrate animals (including insects) and of aquatic vertebrates, so directed as to give as nearly as possible an exhaustive knowledge of a taxonomic group or of a selected geographic assemblage.

*Advanced Economic Entomology.*—A research course in systematic and experimental entomology with application to insects injurious to agriculture and horticulture.

PHYSIOLOGY (HUMAN)—PROFESSOR KEMP

**Advanced Physiology.*—(*a*) The physiology of foods, digestion, and exertion; (*b*) the blood, circulation, and respiration; (*c*) the excretions, especially urine analysis; (*d*) general physiology of nerve and muscle; (*e*) advanced vertebrate, especially human, histology.

GEOLOGY AND MINERALOGY—PROFESSOR ROLFE

**Advanced Mineralogy.*—A study of the forms of crystals, and the identification of minerals by their crystalline forms. The microscopic determination of rock-forming minerals, and methods of separating the mineral constituents of fine grained rocks. *Winter and spring terms.*

**Economic Geology.*—A study of the uses man may make of geological materials, the conditions under which these materials occur, and the qualities which render them valuable.

**Advanced Economic Geology.*—The effects which variations in the chemical composition and physical constitution of inorganic substances used in the arts have on the qualities of the manufactured product, and should have no methods of manufacture. A critical examination of the tests now employed in determining the qualities of building stones.

**Paleontology.*—(a) The biological relations of fossil forms; (b) the principles of classification as applied to fossils, together with the characteristics which distinguish the larger groups; (c) the distribution and variations of the genera and species of one or more of the more important groups.

*Advanced Paleontology.*—A critical and comparative study of the fossils found in the rocks of Illinois.

*Illinois Geology.*—Glacial geology in relation to water supply of drift-covered regions. Dynamic and stratigraphic geo'ogy of the Ozark uplift in Illinois.

CHEMISTRY—PROFESSORS PALMER AND PARR, AND ASSISTANT PROFESSOR GRINDLEY

**Volumetric Analysis.*—Silicate analysis.
**Food and Air Analysis.*—Plant products, feeding stuffs.
**Technological Chemistry.*
**Physical Chemistry.*
**Iron and Steel Analysis, etc.*
**Advanced Organic Chemistry.*

**Sanitary Analysis.*—Waters, etc.

**Theoretical Chemistry.*

**Agricultural Chemistry.*

**Metallurgy.*

**Metallurgical Chemistry.*—(a) Electro-Metallurgy; (b) Electro-Chemical analysis.

**Industrial Chemistry.*—(a) Gas analysis; (b) Urine analysis; (c) Toxicology.

**Seminary.*—Journal readings, reviews, etc.

**Proximate Organic Analysis of Foods, Plants, Drugs, Compounds, etc.*—Research work in inorganic chemistry, in general organic chemistry, in agricultural chemistry, and in metallurgical chemistry, including such special topics as the composition of foods, their nutritive and heat values; the determination of the heating power of fuels, analysis of ores, etc.

PHYSICS—PROFESSOR CARMAN AND ASSISTANT PROFESSOR SAGER

**Electrical and Magnetic Measurements.*—An advanced lecture and laboratory course in the theory and use of electrical and magnetic measuring instruments.

**Advanced Physical Measurements.*—A laboratory course supplemented by recitations and lectures.

**Introduction to Theoretical Physics.*—A course of lectures and recitations, taking up dynamics, fall term; theory of electricity and magnetism, or optics, winter term; and thermodynamics or optics, spring term.

*Investigation of Special Problems.*—An advanced laboratory course. The student is given one or more special subjects of investigation to be conducted throughout the year.

*Mathematical Physics.*—A course of lectures and recitations. The subjects for 1898-99 are theory of electrical and magnetic potential, and Maxwell's theory of electricity and optics, using in the latter course Boltzmann's and Poincare's lectures as references.

*Advanced Physical Measurements and Investigation.*

*Advanced Mathematical Physics.*

ASTRONOMY—PROFESSOR MYERS

**Cosmogony.*—The chief aim of this course is to acquaint the student with the evidence for and against the Nebular Theory.

**Practical Astronomy.*—The use of instruments of precision; the determination of latitude, time, and azimuth with such instruments as are used in the ordinary practice of civil engineering.

**Theory of Orbits.*—The formation and integration of the differential equations of motion of a system of bodies and the derivation of the laws of undisturbed elliptic, parabolic, and hyperbolic motion. *Fall term.*

*Special Perturbations.*—An investigation of the various formulæ and methods for finding the special perturbations of a heavenly body. *Winter term.*

*Celestial Mechanics.*—The laws of motion of a system of bodies.

MATHEMATICS—PROFESSORS SHATTUCK AND MYERS, AND ASSOCIATE PROFESSOR TOWNSEND

*Theory of Equations.*—Fall term.

*Theory of Determinants.*—The origin and notation of determinants, properties of determinants, determinants of special forms with applications to algebra and to analytical geometry. *Winter term.*

*Theory of Invariants.*—The general development of the theory of invariants, both from the geometric and from the algebraic side.

*Theory of Functions.*—The geometric representation of the complex variable, followed by the development of the theory of infinite series, algebraic and transcendental functions, integration of uniform functions, Riemann's surfaces, introduction to elliptic functions, etc. *Fall and winter terms.*

*Method of Least Squares.*—Law of probability and error, adjustment of observations, precision of observations, independent and conditional observations, etc.

*Analytical Geometry of Space.*—A general review of the position of the plane and the right line in space and the more general properties of surfaces of the second degree, the classification and special properties of quadrics, and a brief introduction to the theory of surfaces in general. *Spring term.*

*Higher Plane Curves.*—The general theory of algebraic curves, together with the application of the theory of invariants to higher plane curves; special study of curves of the third and fourth order. *Winter term.*

*Calculus of Variations.*—Elements of the science most needed in the study of the higher subjects of mathematical astronomy and physics. *Fall term.*

*Spherical Harmonics.*—Fourrier's Theorem for developing any function of a variable in a series proceeding in sines and cosines of multiple of the variable is derived and the limitations of its validity investigated, followed by the study of Lagrange's, Laplace's and Larne's functions and their applications to astronomical and physical problems. *Winter term.*

*Potential Function.*—The potential function defined and its properties derived and discussed. The potential of various bodies, such as a wire, a spherical shell, a sphere, ellipsoid of revolution, etc., is computed. Poisson's and Laplace's Equations derived and discussed. *Spring term.*

*Modern Geometry.—A consideration of homogeneous co-ordinates, duality, descriptive and material properties of curves, anharmonic ratios, homography, etc. *Fall term.*

*Algebraic Surfaces.—The application of homogeneous co-ordinates and the theory of invariants to geometry of three dimensions, and also the general theory of surfaces, together with the special properties of surfaces of the third and fourth order. *Fall term.*

## AGRICULTURE

Admission requirements: One year each of chemistry and of biological science.

PROFESSOR DAVENPORT AND ASSISTANT PROFESSOR HOLDEN

*Economic Agriculture.—The influence of physical surroundings and of the elements of fertility upon the yield and the character of agricultural crops. Reaction of different crops upon the soil and upon one another when grown together or in succession. Economic sources of fertility, especially of nitrogen through the agency of bacteria.

*Soils.—A critical study of the processes active within the soil; influence of fertilizer and of crop upon the soil; natural sources of fertility, residues of fertility, as shown by a study of drainage waters; agency of bacteria and the conditions of their activity, and the cumulative effect of manures and of various agricultural practices. *Fall term.*

*Laws of Organic Evolution as Concerned in the Breeding of Domestic Animals.—The nature and extent of variation; natural selection; heredity; crossing; correlated variation.

*Principles of Stock Feeding.—Functional activities of the animal body and products of their metabolism.

*Agricultural Experimentation.—A systematic study of the work of experiment stations and experimenters in this and other countries, together with a critical study of correct principles and methods of experimentation.

*Comparative Agriculture.—Influence of locality, climate, soil, race, customs, laws, religion, etc., upon the agriculture of a country and upon its people; influence of machinery, and of land titles; relation of agriculture to other industries and to the body politic.

## ARCHITECTURE AND ENGINEERING

Admission requirements: The undergraduate course in the College of Engineering.

ARCHITECTURE AND ARCHITECTURAL ENGINEERING—PROFESSOR RICKER, ASSOCIATE PROFESSOR WHITE, AND ASSISTANT PROFESSORS MCLANE, TEMPLE

Primary. Each 1, 2 or 3 credits.

*Construction of Extensive Wooden Buildings.*—Foundations; floors; walls; roofs; economic spacing of columns, girders, and trusses.

*Recent Uses of Stone, Brick and Terra Cotta in Architecture.*—Stone columns, beams, lintels, and walls. Brick walls, piers, screen walls. Terra cotta walls, columns, architraves, cornices, internal finish.

*Metallic Skeleton Buildings.*—Cantilever foundations; wind-bracing; economic spacing of beams, columns, girders, and roof trusses; economics of arrangement and construction.

*Fire-Resisting and Fire-Proof Buildings.*—Methods of construction used and proposed; results of tests and fires; comparative returns from investments.

*Sanitation of Public Buildings.*—Water supply and sewerage of isolated buildings; examination of examples; proposal of improvements; estimates of cost.

*Researches on Evolution of Architectural Styles.*—Development of column, pier, entablature, window and door; changes in uses of architectural elements; modifications in plans, elevations and uses of buildings; influence of climate, materials, and man; progressive decoration.

*Higher Application of Graphic Statics.*—The kern and compression; statics of Gothic structures; steel and tile or concrete vaults and dams; deflection curves of loaded beams and girders; economics of large roofs.

*Heating and Ventilation of Large Buildings.*—Comparison of systems; study of executed examples; designing plant for isolated public buildings; economics of heating and ventilation.

*Higher Studies in Architectural Design.*—The work of an entire term will be devoted to a single problem, a large public or semi-public building; the design will be most important, but sufficient attention must be paid to construction, heating, lighting, etc.

*Researches and Experiments in Applied Esthetics.*—Application of theories of geometrical proportions to selected buildings; measurement of proportions of architectural elements in best styles; experiments in variations.

*Translation of Architectural Works from French or German.*—Summary data; condensations; complete translations in clear, idiomatic English.

Secondary. Mostly 1 credit each.

*Stereotomy Applied to American Problems.*—Arches, straight

or skew; vaults, groin or cloister; domes and pendentives; staircases and stairway vaults.

*Examinations of Heating and Ventilation of Buildings.*—1, 2, or 3 credits. Inspection of completed plants and reports thereon; tests of apparatus; efficiency of arrangements; economy of working.

*Higher Workshop Practice.*—Inspection of wood-working mills, of architecttral iron works, of marble works, terra cotta works, examination of processes employed and reports thereon.

*Photography for Architects.*—Theory and practice of dry plate photography; making negatives of exteriors, interiors, details, and drawings; printing processes.

*Methods of Reproducing Drawings and Specifications.*—Hektograph, mimeograph, blue prints, black prints, colored prints, other processes; drawing for photographic processes.

*Higher Problems and Methods in Perspective.*—1, 2 or 3 credits. Shadows in perspective; oblique perspective; abbreviated methods; reflections.

*Estimates and Specifications for Large Buildings.*—Study of examples; collection of data; general and detailed estimates; outline and complete specifications.

*Higher Industrial Design.*—1 or 2 credits. Sketches and working drawings for furniture and ornamental work for buildings.

*Advanced Water Color Painting.*—Rendering in ink, sepia, or color.

*Office Methods and Arrangement.*—Arrangement of offices for architects; storage of supplies and of drawing of completed work; filing drawings, specifications, etc., of work in progress; book-keeping for buildings; forms of official papers.

*Any Primary Offered in Engineering Subjects.*

*Indexing and Classification of Periodicals, Books, etc.*—Collecting and filing data; decimal system; materials; arrangement of clippings; indexing periodicals, filing drawings.

CIVIL ENGINEERING—PROFESSOR BAKER AND ASSISTANT PROFESSOR PENCE

All subjects are primary unless otherwise stated.

## Railway Engineering

*Location and Construction.*—Advanced work in the economic theory of railway location with relation to the effects of distance, grade, and curve upon operation and maintenance. Estimates, specifications and contracts, and the improvement of existing lines of railway.

*Railway Track and Structures, and Their Maintenance.*—The design of track standards and of minor railroad structures, trestles,

culverts, turn-tables, water tanks, engine houses, etc., with special reference to economic principles of construction and maintenance.

*Yards and Terminals.*—The arrangement of tracks, buildings, etc., at division and terminal points with reference to economy and facility in handling traffic. Personal inspection and report on actual cases.

*Motive Power and Rolling Stock.*—Locomotive construction and performance, and car building and repairs.

*Signal Engineering.*—A study of the various systems of railway signaling. Personal inspections and comparisons of different plants in actual operation.

*Railway Operation and Management.*—The organization and administration of the several branches of service in railway operation.

## Structural Engineering

*Bridge Design.*—A comparative study of the details of standard designs, with personal inspection of the process of manufacture and erection.

*Cantilever and Swing Bridges.*—The computation of stresses, design of parts, method of erection, etc.

*Metallic Arches.*—Computation of stresses and design of metallic arches.

*Metallic Building Construction.*—The computations and drawings of a design for a metal skeleton building, with a consideration of standard connections.

*Roof Construction.*—Computations of stresses and designs of steel roof trusses.

*Stereotomy.*

*History of the Development of Bridge Building.*—Secondary.

## Miscellaneous Subjects

*Practical Astronomy.*—Practice with the astronomical transit zenith telescope, and alt-azimuth in determining time, latitude, and azimuth.

*Geodesy.*—A study of the methods employed in triangulation, with practice in reading angles; base-line measurements: method of least squares and adjustments of triangulation systems; map projection; trigonometrical leveling.

*Critical Description of Engineering Construction.*—Details of methods and cost from personal inspection during progress of construction.

*Translation of Technical Engineering Work from French or German.*

*Any Primary in Theoretical and Applied Mechanics, or Municipal and Sanitary Engineering.*

*Any Subject in Mathematics, or any primary in Mechanical Engineering, or Electrical Engineering*—Secondary.

*Indexing of Civil Engineering Periodical Literature.*

ELECTRICAL ENGINEERING—PROFESSOR CARMAN, ASSISTANT PROFESSORS SWENSON AND ESTY

*Mathematical Theory of Electricity and Magnetism.*—Lectures and recitations with Mascart and Joubert's Electricity and Magnetism as text book.

*Absolute Measurements in Electricity and Magnetism.*—Laboratory course in investigation of special problems.

*Dynamo Electric Machinery.*—Laboratory course in the study of some of the machines belonging to the department, including alternating current apparatus.

*Electric Transmission of Power.*—Course of lectures, with study and design of electric stations according to the best engineering practice.

*Electro-Metallurgy.*

*Photometry.*

In addition to the above courses. minor courses may be taken in mathematics, physics, chemistry, and in any of the engineering courses.

MECHANICAL ENGINEERING—PROFESSOR BRECKENRIDGE AND ASSISTANT PROFESSOR VANDERVOORT

*Advanced Machine Design.*—The work offered under this head embraces a wide range of subjects, and will be arranged along any special line that may be considered profitable for the student.

*Graphics and Kinematics.*—The application of graphical methods of solutions of problems; advanced valve-gear problems; acceleration and velocity diagrams of governors; quick return motions, other important mechanisms.

*Mill Engineering.*—A study of problems arising in connection with installation of power plants and transmission of power.

*Steam Engineering.*—A study of theory and practice of steam generation and use. This may be taken as applied to marine practice, to locomotive practice, to steam heating, or to stationary steam engines and boilers. Advanced study of theory of the steam jacket and of superheating; multiple expansion engines; steam turbines.

*Experimental Engineering.*—Review of standard methods of testing applied to all forms of motors or steam generating apparatus. Numerous experiments and carefully prepared reports are required.

*Thermodynamics.*—Advanced study of theory of heat engines. Solution of numerous problems.

*Pneumatics.*—A study of air compressors and of air transmis-

sion; air motors; blowing engines; fans and blowers. Theory of design and operation. Problems.

*Hydraulic Machinery.*—A study of high and low duty pumping engines; hydraulic transmission of power: centrifugal and rotary pumps; hydraulic presses, elevators, and cranes.

*Mechanical Technology.*—Installation and economic arrangement of machinery. Shop management and systems. Construction of special machine tools. Construction of machinery used in various lines of manufacturing.

*Translation of Technical Engineering Literature.*

*Any Primary Offered in the College of Engineering.*—Secondary.

*Indexing and Classification of Engineering Literature.*—Secondary.

MUNICIPAL AND SANITARY ENGINEERING—PROFESSOR TALBOT

## Water Supply Engineering.

*Tanks, Stand-Pipes, and Reservoirs.*—This subject includes the designing and construction of these structures. Especial attention will be given to the cause of failure of stand-pipes and to requirements for safe construction. A study is made of plans of existing structures and of the methods of construction employed.

*Sources and Requirements of Water Supply for a City, and Removal of Impurities.*—The development and capacity of wells and other sources, standard of purity, chemical and biological action of filters, and their construction and operation.

*Water Works Management and Economics.*—Water works records, revenue, operation, management, franchises and their relation to the public, with a study of existing plants.

*Pumps and Pumping.*—Types of pumps. Design, construction, operation, duty and efficiency. Applicability of different types. Duty trials and tests.

*General Water Works Construction.*—When practicable a discussion will be made of the plans and methods of construction on work with which the student has been connected.

*Biological and Chemical Examination of Potable Water.*—This will be given in connection with the departments of Botany and Chemistry.

*Description of Water Supply Systems.*—Critical discussion of water works systems from personal observation made during construction and upon the operation of similar plants.

## Sewerage.

*Sewage Purification.*—A study of the process and methods and of the results obtainable.

*Sewage Disposal Works.*—Designing. Applicability and efficiency of methods. Cost.

*General Sewerage Design and Construction*—This usually involves actual work of designing and participation in the work of construction of systems of sewers.

*City Sanitation.*—Methods and processes of garbage reduction and disposal. Health and sanitary restrictions and measures.

*Description of Sewerage Systems.*—Critical examination and description from personal observations made during construction and upon the operation of sewerage systems.

## Road Engineering.

*Economic Aspect of Good Roads and Pavements.*—An investigation of the value of road improvements.

*Construction of Roads and Pavements.*—Tests and requirements of materials. Specifications. Comparison of cost, desirability and durability. Grades and location.

## Miscellaneous Subjects.

*Critical Description of Engineering Construction.*

*Translation of Technical Engineering Work from French or German.*

*Any Primary in Civil Engineering.*

*Any Primary in Theoretical and Applied Mechanics.*

*Any Subject in Mathematics or Primary in Mechanical Engineering, or Electrical Engineering.*—Secondary.

*Analytical Mechanics.*

*Indexing of Municipal and Sanitary Engineering Literature in Engineering Periodicals.* (Secondary.)

*Resistance of Materials.*

*Hydraulics and Hydraulic Engineering.*

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